



# RFID – Radio Frequency Identification

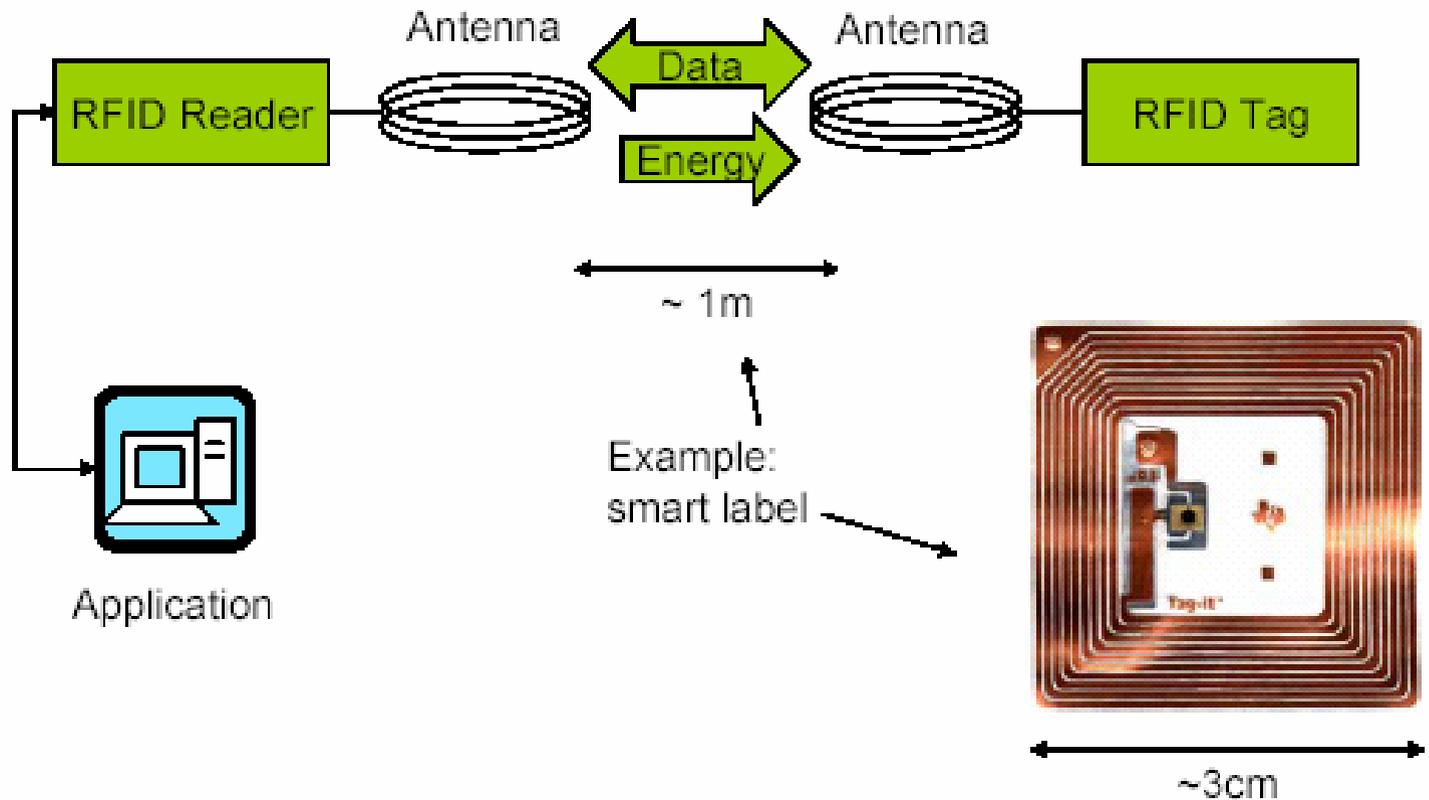
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# Characteristics

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- Identify Objects
  - Typically: from distance
  - Or: in a secure way
- Purpose
  - Associate specific actions, attributes etc. with an object
  - Authenticate an object, person
  - ...
- What techniques do we know?

# RFID Components



# Research Test-bed Platform

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Linux PDA with  
Java2ME – CDC –  
Personal Profile



IEEE 802.11  
wireless card. ad-  
hoc mode

RFID tag reader

# RFID Systems

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- Communication principles
  - Full-duplex and half-duplex
    - Transponder sends during energy transmission
    - Techniques needed to detect weak signals from tag
  - Sequential
    - Turn off field of the reader; tag sends during reader is idle
    - Tag needs a capacitor or battery supply
    - Anti-collision
- Data volume
  - Unique ID
  - From a few bytes to several Kbytes
    - Special 1-bit transponders
    - Possible applications? anti-theft system
- Energy Supply
  - Passive: Energy supply by the magnetic/electric field of the reader
  - Active: Battery supply needed
- Range
  - Close coupling:  $\sim 1\text{cm}$
  - Remote coupling:  $\sim 1\text{m}$

# Anti-collision Bit-Mask Algorithm

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- Example

- Tag1, UID = 1234527

- Tag2, UID = 9898417

- Rader:

- 0th Read:            XXXXXXXX

- 1st Read:            XXXXXX1

- 2nd Read:            XXXXXX2

- ...

- 7th Read:            XXXXXX7

- 8th Read:            XXXXX17                                (READ tag2)

- 9th Read:            XXXXX27                                (READ tag1)

- Number of possible improvements

- Dichotomy search

- ...

# Application Outline

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- Current Applications
  - Constrained environments (doors, gateways)
  - Lots of tags, few readers (short-range)
- Ubiquitous computing Applications
  - Lots of tags and readers (long-range)
- Sensor-based Applications
  - Sensor-powered tags

# Current Applications:

## Access Control

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- Several schools in Osaka will give RFID chips to students, in order to track their presence.
  - The tags will be read by readers installed in school gates and other key locations to track the kids' movements.
  - The chips will be put onto kids' schoolbags, name tags or clothing.
- New Scientist reports that clubbers in Spain are choosing to receive a microchip implant instead of carrying a membership card.
  - The Baja Beach Club in Barcelona offers people signing up for VIP membership a choice to receive a RFID implant.
  - VIP members can jump the entrance queues, reserve a table and use the nightclub's VIP lounge. RFID tag can be used as an in-house debit card.

# Current Applications: Inventory Systems

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- Smart warehouse.
  - Error-free packaging
  - Automatic stocktaking
- Surgery Room
  - Do not leave anything inside someone...
  - Check-in and check-out of all the instruments
- RFID could be slapped on to toothbrushes, chairs and even toilet seats to monitor elderly people in their own homes.
  - Data harvested from the RFID chips would reassure family and care-givers that an elderly person was taking care of themselves, for example taking their medication.
  - Unusual data patterns would provide an early warning that something was wrong.

# Current Applications: Automatic Billing and Tolling

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- Smart (cashier-free) retailers
  - Avoid queues
  - On-line advertisements and special offers
- iPico Holdings has developed and tested RFID passive tags and readers that can be used to monitor vehicles at a read distance of 17 feet traveling at speeds of 160 mph.
  - The technology will be used to control traffic and speed,
  - And will enable immediate traffic ticketing or toll collection



# Current Applications

## Long-term applications

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- RFID tags enable an item to be tracked even after it has been purchased by a consumer.
  - A retailer could recognize a returning customer as he or she walks into the store by surreptitiously reading a tag embedded in the customer's clothing, and use information about the customer's prior purchases to tailor the salesperson's pitch.
- RFtracker is a search engine that tracks and maps the position and movement of RFID tags.
  - RFtracker maintains two databases:
    - "**match**" database, which matches RFID tag numbers with the people who possess goods bearing those tag numbers
    - "**sightings**" database, which holds records of RFID tag sightings by RFID readers located around the world.
  - If you already have a tag number, you can use the "**sightings**" database to see where that tag has been sighted.
  - If you have the name of the person that you want to track, you can start with the "**match**" database, looking for RFID tags associated with that person
- Remember "Minority Report"?

# Ubiquitous Computing

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- Computers wirelessly interacting everywhere.
  - Now: laptop, PDA, smart-phones
  - 2010: fridges, tv, phone, appliances, homes,..., everything!
- RFID
  - Now: the Nokia Mobile RFID Kit allows the user to easily launch services and conveniently access phone functions simply by touching the phone to an RFID tag. Typical scenarios include:
    - Touch and Browse, Touch and Record, Touch and Send Automated Messages, Touch and Call
  - 2010: every item (whatever the value) will be tagged. RFID Tags will be possibly printed – like today barcodes
  - 2010: cheap embedded long range (~10m) readers with anti-collisions

# Ubicomp Applications

## Citywide applications

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- "Ubiquitous City is an intelligent next-generation city based on RFID and wireless internet technologies.
- One of the first efforts to build u-Cities is the development of the convention center district in the Korean city of ChanWon.
- In a u-City, RFID would be used in the following ways:
  - Automated parking system
  - Vehicle identification
  - House keys
  - In-store services: product information, tailor-made clothes, fashion news
  - Automated checkout in retail stores
  - Attach RFID tags to sewer pipes to manage waste water
  - Track locations of vehicles, children and pets

# Ubicomp Applications

## smart appliances applications

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- General Support to Context-Awareness
  - Future smart-phones will read tags around to automatically detect situations and react (see later)
- Future Trashcan
  - when you throw your RFID lunch wrapper in the trash, its RFID will be read by the trashcan. The trashcan will decide if it has to be recycled or shredded or composted.
  - Your lunch wrapper was bought using your debit account and marked with that information. The trashcan can charge you for burdening it with non-recyclable plastic.
- Smart fridge detecting what is in and suggesting recipes
- Smart washing machine detecting what is in and choosing wash-program or test clothes  
“compatibility”

# Ubicomp Applications

## RFID gaming

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- Chipco International developed readers able to scan RFID tags embedded in the chips on the betting area of the table. Readers electronically report the amount of the bet to a security control room. If the player has just changed his betting habits, it may be because he is cheating.
- Smart Jigsaw Puzzle Assistant
  - The user moves the detector over the remaining jigsaw tagged pieces until it detects another piece that can be added to the already combined pieces of the puzzle. Alternatively, the player can choose to pick a random jigsaw piece whose position in the overall puzzle game is then visualized.
- Radar Golf helps players find balls embedded with radio frequency identification chips. RFID chips emit a radio signal that can be tracked with a scanner.

# ...Ok great, but there are alternatives...

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- Barcodes and camera phones:
  - It is possible to scan via a camera-enabled phone a barcode, and with just one click the proper webpage will be loaded on your phone's browser. The camera phone has the potential to disrupt the RFID trend in computing.
- But RFID have some definitive advantages
  - Memory capacity
    - tag single objects instead of classes of objects
  - Works despite occlusions
    - Do not open the boxes
  - Can be dynamically written
    - Innovative applications (micro information repositories dispersed in an environment – see later)



# Coupling Tags with Sensors...

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- The same mechanisms that an RFID reader uses to extract data from an RFID tag can also be applied to collecting sensor data. Extending the chip's interface capabilities to a sensor is straightforward, but the sensor design must address two engineering challenges:
  - the sensor cannot use any power while the tag is not in communication with the reader, which is the usual operating state
  - available energy is very small when the sensor is in reader range, which limits measurement techniques.
  - Alternatively, use battery-powered sensors and rf-id storing the history of sensed data.
- Major RFID sensing application domains include monitoring physical parameters, automatic product tamper detection, harmful agent detection, and noninvasive monitoring.

# Sensor-Tag Applications 1/2

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- Manufacturers are already deploying RFID technology in products that could spoil during transport due to temperature extremes.
- Another useful parameter to monitor is acceleration. Fragile and sensitive products such as computers, glassware, and artwork can withstand only limited stresses before incurring damage.
- Legislation requires tamper-evident retail packaging for many drugs, cosmetics, and other safety-critical products. RFID allows automatic tamper checking of multiple products from a distance, eliminating the need to directly inspect each item.

# Sensor-Tag Applications 2/2

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- Harmful agent detection is determining whether food products have been contaminated with bacteria (either during normal handling or bioterrorist attack). Auburn University is developing an RFID tag that when read will provide a direct measure of contamination due to bacterial growth.
- A surgeon could place an RFID sensor in a patient's body during a single procedure; later the physician could use an external reader to periodically contact the device, perhaps during routine office visits, and obtain a report on this aspect of the patient's health.
- RFID chips with pressure readings installed in cars tires.